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April 8, 1997

Mr. William F. Caton
Secretary
Federal Communications Commission
1919 M. St., NW, Room 222
Washington, D.C. 20554

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Federal Communications Commission
Office of Secretary

RE: Ex Parte Presentation
Universal Service: CC Docket No. 96-45
Access Reform: CC Docket No. 96-262

Dear Mr. Caton,

The attached documents are being submitted to the Federal-State Joint Board and their staff on Universal Service. The first of these documents provides an analysis of the relative efficacy of the Hatfield Model and the BCPM at meeting the set of criteria that define an effective proxy cost model. This analysis shows that the Hatfield Model would be the superior choice for use in determining universal service support costs, unbundled element costs, and carrier access and interconnection costs. The second document is an analysis of the voice and data transmission capabilities of different copper loops that had been requested by the FCC and State staffs.

Two copies of this Notice are being submitted to the Secretary of the FCC in accordance with Section 1.1206(a)(1) of the Commission's rules.

Sincerely,

Richard N. Clarke /[illegible]

Richard N. Clarke

Attachments

cc: Anthony Bush
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Why the *Hatfield Model, v3.1* is the Superior Proxy Model Tool

This memo presents several criteria that should form the basis for selecting one proxy model over another for the purposes of calculating universal service support obligations, unbundled network element costs, and carrier access and interconnection costs.[1] The memo then discusses how well the Hatfield Model, v3.1 ("HM") and the BCPM Model, v.1.1 ("BCPM") meet these criteria for an effective proxy model tool.

1) Completeness

- **Hatfield**

  The HM models explicitly the entire local network. This includes loops, end office switching, interoffice transport (dedicated/common/direct), tandem switching, SS7 signaling (STPs/links/databases), operator/DA systems, and public telephones. It engineers the local network based on the specific lines/minutes/call types demanded by residence versus business customers.

- **BCPM**

  The BCPM models explicitly only the loop and end office switch portions of the local network. The cost of all other local network elements (e.g., interoffice, tandem switching, signaling, etc.) are assumed to be captured by a 3% additive factor to end office switch investments.[2] Only the demand for lines is modeled, no consideration is given to the number of minutes or types of calls that are demanded by customers. Residence customers are assumed to have identical demand volumes and usage patterns as business customers.

- **Discussion**

  Because the BCPM does not consider the complete local network, the costs that it generates cannot be as useful as those generated by the HM. In

[1] In addition to the criteria listed in this memo, there is, of course, the additional criterion of how well the competing models' engineering assumptions meet the specifications for supported universal service outlined by the Joint Board. Because this issue has been addressed at great length in other submissions, it is not discussed here. Suffice it to say that AT&T and MCI believe that the HM engineers far more effectively and efficiently a local network that meets the Joint Board's specifications than does the BCPM.

[2] Not only is BCPM's use of 3% additive factor overly simplistic, but HM calculations demonstrate that it is not correct.

particular, costs for interoffice facilities, tandem switching and signaling may vary greatly among LECs depending on their size in population and in square miles of service area. Furthermore, demands for the above facilities and for end office switching depend importantly on the mix bus/res customers served. Because the BCPM does not take such heterogeneity among different LECs' customer sets or serving areas into account, it is an inferior tool relative to the HM.

2) Data Accuracy

- **Hatfield**

  The HM 3.1 uses a detailed data set developed by PNR from Census Bureau, Claritas and Donnelly to determine the number of residence, business, special access and public telephone lines in each CBG. Information is also collected at the CB level to determine the amount of area in each CBG that is empty. CBGs are associated with wire centers based on an analysis of the NPA-NXXs of the telephone numbers of the business and residence inhabitants of the CBG. Housing unit information is collected to determine instances of high-rise or multi-family development.

- **BCPM**

  BCPM uses the data methodology that Hatfield used in its earlier v2.2.2 release. This cruder methodology assumes no variation across CBGs in a state as to residence telephone penetration or in telephone lines per business employee. The BCPM associates a CBG with a wire center based entirely on the geographical location of the CBG's centroid relative to certain wire center boundary maps.

- **Discussion**

  The HM 3.1 data, which incorporate over 90 million records of geo-coded customer locations and telephone numbers, locate far more precisely customer demand. In addition wire center assignments are based on actual counts of the relative number of lines in the CBG served by a particular wire center. In contrast, the BCPM assumes that a CBG's geographical centroid location determines completely its wire center assignment.

3) Consistency

- **Hatfield**

  The HM calculates costs consistently for all uses of the local network (e.g., basic/universal service, toll service, unbundled network elements, carrier access, carrier interconnection). In addition, because the HM permits a granular definition of customer demand (e.g., bus/res, minutes, call attempts, call type, etc.) the effects of varying these demand patterns on network costs can be evaluated. Together, these characteristics assure that all scale and scope economies are properly accounted for, and that costs are properly associated with the causing service.

- **BCPM**

  Because the BCPM does not compute the cost of the complete local exchange network, and because the model's sponsors have chosen to design the model only to report costs at aggregated levels (e.g., basic local service) and not by network element (e.g., NID, loop distribution, loop concentration, loop feeder) it cannot be used to cost items other than basic service. These characteristics impair the usefulness of the BCPM.

- **Discussion**

  Because the HM is a complete and granular model, its usefulness is multiplied. It may be used by policy makers to evaluate the cost effects of various different uses of the local network, and may be used to evaluate the effects of other changes in customer demand such as increased Internet usage, toll calling or 800 calling. Results from the BCPM, because they are reported only at an incomplete and aggregate level, are far less useful.

4) Flexibility

- **Hatfield**

  The HM contains 660 user-adjustable input variables that cover the complete specification of the model. Because these variables define not only input prices and customer demand characteristics, but also certain key engineering specifications, the HM can model the full range of characteristics and situations that may face U.S. LECs. This level of flexibility is demonstrated by the HM's capability to be specified to match the input prices, engineering logic, and output costs of the BCPM. This capability permits a full analysis of the cost drivers in the model.

- **BCPM**

  While the BCPM also permits user-specification of a large number of inputs, certain key variables and engineering practices are hard-wired into the model and cannot be adjusted by the user. No characteristics of customers beyond the number of lines they demand can be input or adjusted. In particular, no user adjustment is possible within the BCPM to account for customer location clustering. In addition, BCPM has not demonstrated any capability to be specified to match the input prices, engineering logic, or output cost of the HM.

- **Discussion**

  Because so many crucial parameters that define local network costs (e.g., drop wire length, customer clustering, etc.) are not adjustable within the BCPM, it cannot be manipulated sufficiently by policy makers either to correct errors that are discovered or to perform sensitivity studies to determine its significant cost drivers. Given the more rudimentary structure and logic of the BCPM compared with Hatfield, it is doubtful that it could be specified to match the input prices, logic and output costs of the HM.

5) Documentation

- **Hatfield**

  All of the input data used in the HM, its engineering logic and its default input parameter values have been extensively documented in written form. Furthermore, all of the supporting analyses behind the model are open to public view and criticism. The model itself operates in modular form, with voluminous intermediate results produced in readable, user-friendly form for further analyses.

- **BCPM**

  The BCPM has only been documented in part. The only documentation provided for many key pieces of input data is that they were provided to the sponsors by various LEC employees (e.g., "business phone line count per CBG from spreadsheets by John Banks of Sprint, CBG area adjustments from files by Peter Copeland of US West"). These data have not been verified through public inspection. Documentation is also lacking for certain key studies of switching costs and network expenses that are used as inputs to the model. Intermediate results from the BCPM are extremely sketchy, and are not provided to the user in an easily readable fashion.

- **Discussion**

  Because the documentation of the BCPM is so incomplete, it is impossible to really understand how the model operates and what drives its results. Furthermore, this lack of documentation discourages policy maker experimentation with the model. In contrast, the HM is explained in far more detailed fashion, and this permits regulators to gain a greater understanding of its characteristics.

6) Auditability

- **Hatfield**

  All of the input data, engineering logic, calculations and support for the default user-adjustable input parameter values of the HM are completely open to public scrutiny and review. Not only are all intermediate results captured for further analyses, but outputs are reported at an extremely granular level so that costs generated by the model may be compared with other sources of information (e.g., equipment supplier catalogs, regulatory studies of access, interconnection, switching and local service costs, etc.). The HM has also been submitted in numerous state dockets where it has been subject to discovery, interrogatories and cross-examination by all interested parties.

- **BCPM**

  Key portions of the input data, and support for the BCPM sponsors' default input parameter values are held behind a proprietary veil. Analyses cannot be performed on the study of switching costs that the sponsors' used to populate the model. Similarly inaccessible is the study of "forward-looking" expenses that was used to set the $11.34 per line per month figure that was entered into the model. This is especially worrisome because this unauditable expense figure represents over one third of total monthly costs calculated by the BCPM. In general, the BCPM has been advanced only in the Federal USF proceeding, and has not been open to discovery, interrogatories and cross-examination by interested parties.

- **Discussion**

  The fact that the BCPM sponsors, who are all ILECs, have chosen not to make available for public review all of the input data and support for their default parameter values is distressing. Not only does this prevent regulators and other interested parties from becoming comfortable with the model, but it also raises doubts about the consistency of these model input items with other items of evidence (e.g., contracts, invoices, receipts, studies) that may be in the ILECs' possession. It is also curious that in general, the ILEC sponsors of the BCPM have declined to submit it into the record of the numerous state proceedings where it may be germane, but also subject to extensive discovery.

QUALITY OF VOICE AND DATA TRANSMISSION ACROSS COPPER LOOPS OF VARYING LENGTH

I. Overview

This paper demonstrates that the Hatfield Model's (HM's) current engineering specifications permit the transmission of high quality analog voice and data across all of its copper loops. Furthermore, for over 99% of the HM's copper loops, the transmission of basic rate ISDN (2B+D) is also feasible. In contrast, the BCPM model engineers its copper loops not only to carry the above services, but also to carry higher bit rate business or entertainment services such as DS1 or HDSL.

II. Introduction

An important issue in designing a local telephone network is the quality of voice or data transmissions across its copper loops. It is well known that, all things being equal, the longer the copper loop, the more difficult it becomes to maintain the quality of voice or data transmission. The key issues then, are twofold. One, what should be the minimum universal service requirement for analog bandwidth or digital data capability of the supported network's copper loops? And, second, what are the engineering specifications for the network's copper loops that will meet this requirement? This paper deals briefly with the first of these two issues, but focuses on the second.

III. Transmission Design Requirements

While certain customers of local telephone service have a need for high bandwidth services, these needs are generally not thought to be eligible for universal service support. As the Federal-State Joint Board indicated in its August 8, 1996 Recommended Decision in CC Docket No. 96-45 on Universal Service,

> … we recommend that … voice grade access to the public switched telephone network … be designated for universal service support …. [Recommended Decision, ¶46]

While the Joint Board may have recommended support only for "voice grade access," this does not imply that data transmission over the supported network is infeasible. To the contrary, as the following discussion demonstrates, a network designed to provide voice grade access will also be capable of handling substantial data transmission throughputs. But, rather than deciding here exactly what the supported level of voice/data transmission quality should be, this paper will instead simply consider four alternatives for transmission design. It will then describe the characteristics of the copper loop network that are necessary for the network to be capable of meeting the specified transmission quality.

These alternative transmission requirements with their voice/data throughput capabilities are:

1) Analog voice
"... commercially acceptable quality for telephone communications is ... bandlimited to the range of frequencies...between 200 Hz and 3500 Hz."[1] Note that this range is limited both by the bandwidth of the loop and by the switch. In particular, digital switches are designed only to process signals between approximately 200 Hz and 3400 Hz in frequency.[2] This switch processing limit is imposed by bandpass filtering in the codecs that perform the analog to digital signal conversions. This same filtering is performed by digital loop carrier systems as well.

1) Analog data (28.8 kbps modem, ITU-T recommendation V.34,)
Modems meeting this standard attempt to use the maximum bandwidth available over the loop.[3] These modems "probe" the communications channel at the beginning of each connection to determine its characteristics. They then dynamically adjust the modem's internal parameters to transmit a data signal at the maximum bit rate possible over the channel.[4]

It is not unusual for users of V.34 modems to see connect speeds of only 21.6, 24.0 or 26.4 kbps – even on short loops which transmit relatively high signal levels. On longer loops, including those with loading coils, V.34 modems can be very effective at finding the maximum amount of bandwidth available over the connection and the location of this bandwidth within the

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1 *Engineering and Operations in the Bell System*, 2nd ed., AT&T Bell Laboratories, 1983 (hereafter, EOBS) Section 6.1.1, p.194

2 See, Bellcore, *BOC Notes on the LEC Networks - 1994* (hereafter, BNLN), Section 7.8, Table 7-2, p.7-28.

3 "Analog V.34 modems utilize nearly the full bandwidth of the present day phone system (actually, more than the 'rated' bandwidth)." "Curt's High Speed Modem Page," Internet: http://www.teleport.com/~curt/modems.html.

4 See, Forney, G. David, Jr., Les Brown, M. Vedat Eyuboglu, John L. Moran, III, Motorola, Inc., "The V.34 High-Speed Modem Standard," *IEEE Communications Magazine*, (December 1996), pp. 28-33.

analog spectrum provided over the loop.[5] After testing current modems under such conditions, modem developers have concluded that a V.34 modem should be capable of maintaining 24 kbps of throughput.[6]

1) Digital Subscriber Line (DSL) for ISDN Basic Rate Access (160 kbps, bi-directional
DSL permits the bi-directional transmission of 2B+D ISDN channels (64 kbps B-channels, 16 kbps packet data D-channel).[7] While the 2B+D channels transmit only at a total of 144 kbps, an extra 16 kbps of throughput is needed to accommodate network overhead.[8]

1) DS1 or High Bit-Rate Digital Subscriber Line (HDSL)
These services require at least 1.5 Mbps of throughput over two twisted copper pairs. (BNLN, Section 12.12.2, p.12-45).

IV. Loop Engineering Specifications Necessary to Meet Given Transmission Requirements

BNLN, Section 7.15 (pp.7-66 to 7-69) cites three different loop engineering designs and the services transmittable on each. They are as follows:

a) Carrier Serving Area (CSA)
This design restricts copper loop lengths to 12 kft that are nonloaded, use 24 or coarser gauge cable, and have no more than 2.5 kft of bridged tap length, with no single tap longer than 2.0 kft. This design supports analog voice, ISDN DSL, 56 kbps data and certain special services.

b) Revised Resistance Design (RRD)
This design specifies a maximum copper loop length of 18 kft (including bridged tap) for nonloaded loops. For these nonloaded loops of 18 kft or less, RRD supports ISDN DSL, in addition to traditional analog services.

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5 Modem testing procedures include the use of several standard loop designs, some of which include extremely long loops with several sets of loading coils. See, Briere, Daniel. "Test underscores differences in modem throughput," *Network World*, (May 10, 1993), pp. 40-43. See also, "V.FAST Class Modems," *InfoWorld*, (July 11, 1994).

6 "Experience indicates a rate of 28.8 kbps can be achieved over the majority of lines in North America, Europe, and Japan, and 24 kbps over practically all lines except for intercontinental links with ADPCM, where 16.8 of 19.2 kbps is often the practical limit." [Forney, et al., p.32]

7 See, BNLN, Section 7.15.6, p.7-69, Section 12.2, p.12-5, and Section 12.9.1, p.12-31.

8 See, BNLN, Section 12.9.1, p. 12-31.

c) Modified Long Route Design (MLRD)
Permits resistances of 1500 to 2800 ohms on full H88 loaded copper loops.[9] The placement of load coils on these loops causes signals above 3000 Hz in frequency to be attenuated.[10] While analog voice and modem services are supported over these loops, digital services are not.

The HM as currently specified at its default parameter values incorporates both RRD and MLRD. Copper loops under 18 kft are not loaded and are generally capable of supporting voice, V.34 analog data at 28.8 kbps and ISDN DSL at 160 kbps.[11] Copper loops beyond 18 kft are engineered according to MLRD. Because they are fitted with load coils, these loops will provide only about 3000 Hz of bandwidth (versus about 3200 to 3300 Hz on RRD or CSA loops). While this accommodates very reasonable voice quality and data transmission over a V.34 modem at 21.6 or 24 kbps, it does not permit the transmission of digital services. MLRD over 19 gauge cable can, however, transmit its signal out to 210 kft or 40 miles.[12]

V. Conclusions

Thus, the conclusions of this paper are as follows:

a) The HM model permits excellent voice quality on all its loops, and V.34 analog data of 21.6 kbps or better on all of its loops.

b) On the HM loops less than 18 kft, ISDN DSL is also available. These constitute over 99% of all the loops engineered by the Hatfield Model.

c) The engineering justification for the BCPM's requirement that no copper loop exceed 12 kft appears to be driven by its sponsors' desire to make these loops capable of carrying DS1 or HDSL high bit rate business or entertainment

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9 H88 loaded loops have load coils with 88 millihenries of inductance placed at 6000 foot intervals.

10 See, EOBS, pp. 333-335.

11 See BNLN, Section 7.15.6, p.7-69, "Almost all loops designed to resistance design criteria, whether RRD or its predecessors, will transmit a DSL signal out to 18 kft.

See, also BNLN Section 12.2, p.12-5, "New digital signal processing techniques, such as those used in the ISDN Basic Rate Access DSL permit the deployment of 160 kbps signal on most nonloaded loops (≤ 1300 ohms) without any conditioning."

And BNLN, Section 12.9, p.12-32, "The DSL system is intended to operate on nearly all unloaded loops 18 kft or less in length."

12 See, EOBS, p. 338.

services. This goal is made clear because BNLN Table 7-11 on p. 7-68 specifies that these types of special services are the only ones provisionable on CSA loops, but may not be provisionable on RRD loops greater than 12 kft in length. In addition, the BCPM documentation states the following:

> "The 12,000 foot breakpoint also facilitates the provisioning of services up to DS1." (p. 7); and:

> "Distribution plant ... [in the BCPM model] ... may utilize digital carrier when terminations are made at the DS1 signal level for a percentage of business lines." (p. 11)

April 7, 1997